

REMARKS

The Office Action mailed October 3, 2007, has been received and reviewed. Claims 1-20, 22-31, and 38-46 are currently pending in the application. Claims 1-20, 22-31, and 38-46 stand rejected.

Claims 1 and 38 have been amended to improve clarity and form. Claims 5, 7-19, and 43 have been amended to improve antecedent basis. No new matter has been added.

Applicants have amended claims 1, 5, 7-19, 38 and 43, and respectfully request reconsideration of the application as amended herein.

35 U.S.C. § 103(a) Obviousness Rejections

Obviousness Rejection Based on U.S. Patent No. 5,326,923 to Cooper *et al.* in view of the American Chemical Society publication to Seapan *et al.*

Claims 1-20, 22-31, and 38-46 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,326,923 to Cooper *et al.* (“Cooper”) in view of American Chemical Society publication to Seapan *et al.* (“Seapan”). Applicants respectfully traverse this rejection as to the remaining claims, as hereinafter set forth.

To establish a *prima facie* case of obviousness, the prior art reference (or references when combined) must teach or suggest all the claim limitations. *In re Royka*, 490 F.2d 981, 985 (CCPA 1974); *see also* MPEP § 2143.03. Additionally, the Examiner must determine whether there is “an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *KSR Int’l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1740-1741, 167 L.Ed.2d 705, 75 USLW 4289, 82 U.S.P.Q.2d 1385 (2007). Further, rejections on obviousness grounds “cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *Id* at 1741, quoting *In re Kahn*, 441, F.3d 977, 988 (Fed. Cir. 2006). Finally, to establish a *prima facie* case of obviousness, there must be a reasonable expectation of success. *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986). Furthermore, the reason that would have prompted the combination and the reasonable expectation of success must be found in the prior art, common knowledge, or the nature of the problem itself, and not based on the Applicant’s disclosure. *DyStar Textilfarben GmbH & Co. Deutschland KG v. C. H. Patrick Co.*, 464 F.3d 1356, 1367 (Fed. Cir. 2006); MPEP § 2144. Underlying the obvious determination is the fact that statutorily

prohibited hindsight cannot be used. *KSR*, 127 S.Ct. at 1742; *DyStar*, 464 F.3d at 1367.

A *prima facie* case of obviousness under 35 U.S.C. § 103(a) has not been established against any of claims 1-20, 22-31, and 38-46 because the applied references themselves or the inferences and creative steps that a person of ordinary skill in the art would have employed at the time of the invention would not have taught or suggested the claim limitations. Additionally, the Examiner has not provided a reason that would have prompted a person of ordinary skill in the relevant field to combine the applied references in the manner asserted, and there would not have been a reasonable expectation of success for combining the teachings of Cooper and Seapan.

Cooper teaches a solvent extraction process for regenerating a solid acidic catalyst that is used to alkylate an isoparaffin with an olefin to produce an alkylate. Cooper at column 6, lines 7-12 and column 6, line 35-column 7, line 1. The alkylation reaction involves contacting the isoparaffin with the olefin in the presence of the solid acidic catalyst and a Lewis acid at a temperature ranging from -30°C to 50°C to produce the alkylate. *Id.* at column 9, lines 24-35. The isoparaffin has from four to ten carbons, such as isobutane. *Id.* at column 9, lines 53-57. The olefin has from three to five carbons. *Id.* at column 9, lines 57-59. A mixture of highly branched alkanes is produced by the alkylation reaction. *Id.* at column 9, lines 60-61. After being deactivated by residue produced by the alkylation reaction, the solid acidic catalyst is regenerated by contacting the solid acidic catalyst with a liquid solution including a solvent, such as SO₂, oxygenates, such as C₁-C₄ alcohols, ketones, and aldehydes, nitriles, or phenols. *Id.* at column 10, lines 29-38. The liquid solution removes a portion of the reaction residue produced by the alkylation reaction. *Id.* at column 10, lines 56-58. The regenerating process is performed at a temperature of between 0°C-50°C. *Id.* at column 11, lines 5-7.

Seapan teaches regenerating a catalyst using a supercritical fluid extraction technique. Seapan at p. 79. Tetrahydrofuran, pyridine, SO₂, and CO₂, were tested under supercritical conditions to determine their respective abilities to remove coke from the catalyst. *Id.* at p. 82. Of the tested solvents, pyridine, SO₂, and CO₂ effectively removed coke from the catalyst. *Id.* at p. 83-88.

The Applied References Do Not Teach or Suggest All of the Claim Limitations and the Office Does Not Provide an Articulate Reason Why the Differences between the Applied References and the Claims Would Have Been Obvious

The applied references do not teach or suggest all of the limitations of claim 1 because neither Cooper nor Seapan, alone or in combination, teach or suggest “contacting the catalyst with a fluid reactivating agent at or above a critical point thereof, the fluid reactivating agent comprising a source of a hydride ion.” To the contrary, Cooper teaches contacting a solid acid catalyst with a liquid solution to regenerate the solid acid catalyst. The liquid solution used to regenerate the solid acid catalyst of Cooper includes SO₂, C₁-C₄ alcohols, ketones, aldehydes, nitriles, or phenols, none of which includes a source of a hydride ion. In addition, since the solid acidic catalyst of Cooper is contacted with a liquid solution to conduct the regeneration, the liquid solution is, by definition, not at or above its critical point. Since Cooper does not teach or suggest a fluid reactivating agent comprising a source of a hydride ion source and does not teach or suggest that the fluid reactivating agent is at or above its critical point, Cooper does not teach or suggest the above-mentioned limitation.

The Examiner relies on the mention of isobutylene, isobutane, and benzene in Cooper as teaching compounds “which would be capable of transferring a hydride ion.” Office Action of October 3, 2007, p. 2-3. However, the benzene mentioned at column 3, lines 64-65 of Cooper is a starting material used in the alkylation reaction. Since the alkylation reaction is conducted at a temperature that maintains the reaction in a liquid phase, the benzene is not at or above its critical point when the benzene contacts the solid acidic catalyst of Cooper. Cooper at column 1, lines 43-46. The Examiner also relies on column 5, lines 1-3 and column 10, lines 61-63 of Cooper as teaching benzene. However, after a close review of these sections of Cooper, Applicants respectfully submit that these sections do not teach or suggest benzene.

Similarly, Cooper teaches isobutylene (column 9, line 35) and isobutane (column 9, lines 41-43 and lines 56-57) as starting materials for the alkylation reaction and not as reagents used in catalyst regeneration. Cooper states that “[t]he feedstreams introduced into the catalyst desirably comprise isoparaffins having from four to ten carbon atoms and, most preferably, four to six carbon atoms. Isobutane is most preferred because of its ability to make high octane alkylate.” Cooper at column 9, lines 53-57. Regarding isobutylene, Cooper states that “[l]ower temperatures ...are particularly preferred if the feedstream contains more than about 1% isobutylene.” *Id.* at column 9, lines 31-35. As such, Cooper teaches isobutane and isobutylene as components of a feedstream that are converted to alkylates using the alkylation reaction. During the alkylation reaction, these starting materials are maintained in a liquid phase and,

therefore, are not at or above their respective critical points. *Id.* at column 9, lines 38-41. To the contrary, Cooper teaches that the alkylation reaction is conducted at low temperatures, such as between -30°C and 50°C.

Seapan also does not teach or suggest the above-mentioned limitation because pyridine, SO₂, or CO₂ do not comprise a source of a hydride ion. As such, Seapan necessarily does not teach or suggest the above-mentioned limitation.

The Examiner asserts that “Seapan discloses supercritical treatment and the hydrocarbon reactivating agents of Cooper are hydride ion sources of Cooper are hydride ions sources because they contain hydrogen atoms.” Office of October 3, 2007, p. 5. While Seapan teaches a catalyst regeneration process utilizing a solvent under supercritical conditions, the “hydride ions sources” of Cooper, as referred to by the Examiner, are part of a feedstream. The Examiner has not provided a clear explanation of what is meant by “a hydrocarbon reactivating agent.” As best understood by Applicants, the Examiner is relying on isobutane and isobutylene that are present in the feedstream of the hydrocarbon conversion process of Cooper as “hydrocarbon reactivating agents.” *Id.* However, Cooper states that “the regeneration step involves the steps of separating the solid catalytic material from the product of the hydrocarbon conversion process by use of a liquid-solid separation technique and followed by the step of contacting the catalytic material with a solvent capable of regenerating the material.” Cooper at column 10, lines 8-13. Accordingly, the solid catalytic material of Cooper is separated from the feedstream (*i.e.*, isobutane, isobutylene and benzene) before it is contacted with the solvent (*i.e.*, SO₂) used for regeneration. Since the isobutane, isobutylene and benzene are removed before the regeneration process, the isobutane, isobutylene and benzene are not involved in the regeneration process.

Therefore, even assuming, *arguendo*, that one of ordinary skill in the art would have been prompted to use the reaction of Seapan in combination with the process of Cooper (which Applicants do not concede), no source of a hydride ion would be present. Accordingly, neither Cooper nor Seapan, alone or in combination, teach or suggest a source of a fluid reactivating agent at or above a critical point and that includes a source of a hydride ion.

Cooper and Seapan, alone or in combination, also do not teach or suggest the limitation of “transferring the hydride ion from the fluid reactivating agent to the at least one fouling agent,” as recited in claim 1. Since neither reference teaches or suggests a fluid reactivating agent comprising a source of a hydride ion and contacting a catalyst with such a fluid reactivation

agent, the cited references do not teach or suggest transferring a hydride ion from the fluid reactivating agent to the at least one fouling agent. Since the liquid solution used for regeneration in Cooper does not include a source of a hydride ion, Cooper does not teach or suggest transferring a hydride ion from its liquid solution to the residue on the solid acidic catalyst. The Examiner acknowledges that Cooper does not teach or suggest this limitation. Office Action of October 3, 2007, at p. 3. Since Seapan teaches using pyridine, SO_2 , or CO_2 to remove coke from its catalyst and since none of these compounds includes a source of a hydride ion, Seapan does not teach or suggest transferring a hydride ion from these compounds to the coke.

Furthermore, even if Cooper and Seapan were combined, the claimed invention would not be produced because the catalyst would not be contacted with a fluid reactivating agent comprising a source of a hydride ion. As previously discussed, neither Cooper nor Seapan teaches or suggests contacting their respective catalysts with a fluid reactivating agent comprising a source of a hydride ion at or above its critical point. At best, the combination of Cooper and Seapan would result in contacting the solid acidic catalyst of Cooper with a liquid solution of pyridine, SO_2 , or CO_2 . Alternatively, the combination of Cooper and Seapan would result in contacting the catalyst of Seapan with supercritical SO_2 , oxygenates, such as $\text{C}_1\text{-C}_4$ alcohols, ketones, and aldehydes, nitriles, or phenols.

Since Cooper and Seapan, alone or in combination, do not teach or suggest the limitations of “contacting the catalyst with a fluid reactivating agent at or above a critical point thereof, the fluid reactivating agent comprising a source of a hydride ion” and “transferring the hydride ion from the fluid reactivating agent to the at least one fouling agent,” the Examiner has failed to show that the applied references teach or suggest all the claim limitations. Applicants note that, “[w]hile the references need not teach or suggest all of the claimed limitations, the Office must explain why the differences between the prior art and the claimed invention would have been obvious to one of ordinary skill in the art.” *Federal Register*, 72:195 (October 10, 2007) p. 57528. However, the Examiner has not articulated a reason why it would have been obvious to one of ordinary skill in the art to utilize a fluid reactivating agent at or above the critical point that includes a source of a hydride ion to regenerate a catalyst. Having been provided with no articulated reasoning, Applicants are left to speculate as to what reasons the Examiner believes support a legal conclusion of obviousness. As such, it is respectfully submitted that the

Examiner has relied on *ex post* reasoning in reading the teachings of the as-filed specification into the applied references.

Claims 2-20, 22-31 and 45 are allowable, *inter alia*, as depending from an allowable base claim.

Claim 4 is further allowable because the cited references do not teach or suggest providing the catalyst at least partially deactivated by at least one hydrogen deficient fouling agent. The Examiner argues that Cooper teaches this limitation because “Cooper ‘923 discloses isobutylene.” Office Action of October 3, 2007, p. 3. However, as previously described, the isobutylene in Cooper is one of the starting materials of the alkylation reaction.

Claim 5 is further allowable because the cited references do not teach or suggest contacting the catalyst with the fluid reactivating agent comprising a solvent that reacts with the at least one fouling agent to facilitate removal, in total or in part, of the at least one fouling agent from a surface of the catalyst.

Claim 7 is further allowable because the cited references do not teach or suggest contacting the catalyst with the fluid reactivating agent including an alkane having at least one tertiary carbon atom or a compound that can be isomerized in the presence of the catalyst to form at least one tertiary carbon atom, the fluid reactivating agent at or above its critical point. The Examiner states that Cooper teaches this limitation because Cooper “discloses isobutane and 750 psig.” Office Action of October 3, 2007, p. 4. However, the section of Cooper relied upon by the Examiner in support of this assertion is taken out of context. Instead, the relied-upon section of Cooper relates to the alkylation process, not to the regeneration process of Cooper. Furthermore, since Cooper teaches that the pressure during the alkylation reaction maintains the reactants in a liquid phase, Cooper does not teach or suggest that the isobutane is at or above its critical point.

Claim 8 is further allowable because the cited references do not teach or suggest contacting the catalyst with the fluid reactivating agent including a compound selected from the group consisting of isobutane, isopentane, and mixtures thereof for similar reasons as claim 7.

Claim 9 is further allowable because the cited references do not teach or suggest contacting the catalyst with the fluid reactivating agent including a compound selected from the group consisting of n-butane, n-pentane, and mixtures thereof for similar reasons as claim 7.

Claim 10 is further allowable because the cited references do not teach or suggest

contacting the catalyst with the fluid reactivating agent including an aromatic compound selected from the group consisting of benzene, toluene, ethylbenzene, and mixtures thereof for similar reasons as claim 7.

Claim 11 is further allowable because the cited references do not teach or suggest contacting the catalyst with the fluid reactivating agent including at least one of a dissolved species of hydrogen or oxygen.

Each of claims 12-17 and 19 is further allowable because the cited references do not teach or suggest contacting the catalyst with a fluid reactivating agent at or above a critical point wherein the fluid reactivating agent includes a source of a hydride ion.

Claim 18 is further allowable because the cited references do not teach or suggest contacting the catalyst with isobutane at a pressure in the range of about 200 psig to about 5000 psig for similar reasons as claim 7.

Claim 20 is further allowable because the cited references do not teach or suggest transferring the hydride ion from the fluid reactivating agent to the at least one fouling agent and, therefore, does not teach or suggest stabilizing the at least one fouling agent.

Claim 22 is further allowable because the cited references do not teach or suggest releasing the at least one fouling agent having a molecular weight approximately equal to or greater than the molecular weight of the at least one fouling agent deposited on the catalyst. The Examiner states that it would have been obvious “that a hydride ion has a lower molecular weight than the disclosed solvents of Cooper.” Office Action of October 3, 2007, pp. 4-5. However, claim 22 does not recite the molecular weight of the hydride ion or of solvents and does not recite releasing the hydride ion. Instead, claim 22 recites that the molecular weight of the fouling agent released from the catalyst is approximately equal to or greater than the molecular weight of the fouling agent deposited on the catalyst.

Claims 24 and 25 are further allowable because the cited references do not teach or suggest adsorbing the at least one fouling agent to a solid material (as recited in claim 24) and adsorbing the at least one fouling agent to a solid material selected from the group consisting of alumina, molecular sieves, and activated carbon (as recited in claim 25). The Examiner argues that these limitations are taught because Cooper “discloses zeolites and alumina.” *Id.* However, the Examiner overlooks the remaining language of these method limitations, which recites adsorption of the at least one fouling agent to a solid material, such as alumina, molecular sieves,

or activated carbon.

Cooper and Seapan, alone or in combination, also do not teach or suggest all of the limitations of independent claim 38. Specifically, the cited references do not teach or suggest the limitations of “contacting the at least one catalyst with the fluid reactivating agent at or above a critical point of thereof,” wherein “a fluid reactivating agent [comprises] a hydride ion” and “transferring the hydride ion from the fluid reactivating agent to the at least one fouling agent” for substantially the same reasons as discussed above for claim 1.

Claims 39-44 and 46 are allowable, *inter alia*, as depending from an allowable base claim. New claim 46 is also allowable, *inter alia*, as depending from an allowable base claim.

Claim 43 is further allowable because the cited references do not teach or suggest generating pressure and temperature conditions such that the fluid reactivating agent comprising the hydride ion is at or above a critical point of the fluid reactivating agent and is of sufficient density to dissolve the impurities.

One of Ordinary Skill in the Art at the Time of Invention Would Not Have Been Prompted To Combine Cooper and Seapan

It is further submitted that, without the benefit of hindsight, there is no reason in the applied references, common knowledge, or the nature of the problem itself that would have prompted a person of ordinary skill in the art to combine Cooper and Seapan in the asserted manner.

Applicants note “the corollary principle that when the prior art teaches away from combining certain known elements, discovery of a successful means of combining them is more likely to be nonobvious.” *KSR*, 127 S.Ct. at 1740. The Examiner states that “it would have been obvious to one of ordinary skill in the art at the time the invention was made to use the reaction of Seapan in the regeneration process of Cooper because Cooper refers to Seapan’s disclosure of supercritical SO₂ to remove impurities . . . and Cooper [sic] [Seapan] discloses his treatment with supercritical reactive and strong solvents to break down macromolecular structures.” Office Action of October 3, 2007, p. 3. While the background section of Cooper refers to the alkylation process of Seapan, Cooper teaches away from contacting a catalyst with a fluid reactivating agent at or above a critical point where the fluid reactivating agent includes a hydride ion. Specifically, Cooper teaches that the catalyst is active between temperatures as low

as -30 °C to temperatures nearing 50 °C and that “[l]ower temperatures (-5 °C to 15 °C) are preferred because of the enhanced octane of the alkylate produced and are particularly preferred if the feedstream contains more than about 1% isobutylene.” Cooper at column 9, lines 29-35. As previously discussed, the Examiner relies on the presence of isobutane, isobutylene and benzene in the feedstream of Cooper as being “capable of transferring a hydride ion.” Office Action of October 3, 2007, p. 3. However, the as-filed specification teaches that isobutene has a critical temperature of 134.7 °C. *See* as-filed Specification, Table 1. As shown in Exhibit A and Exhibit B submitted herewith, isobutylene has a critical temperature of 144.8 °C and benzene has a critical temperature of 288.9 °C. *See* Exhibit A, page 3 and Exhibit B, page 4. Accordingly, isobutane, isobutylene and benzene would not be at or above their critical points at the temperatures Cooper teaches for the alkylation reaction.

Moreover, Cooper’s reference to Seapan does not suggest the desirability of the combination or provide an objective reason to combine the teachings to produce the claimed invention. As described above, the regeneration processes of Cooper and Seapan are performed under different temperature and pressure conditions. The regeneration process of Cooper is performed at -30 °C to 50 °C with a liquid solution, while the regeneration process of Seapan is performed with pyridine, SO₂, or CO₂ under supercritical conditions. Since it is known in the art that solvents have different properties at noncritical conditions versus critical conditions (see, for example, Seapan at p. 81-82), one of ordinary skill in the art would not be motivated to combine the solvent extraction regeneration process of Cooper with the supercritical fluid extraction regeneration process of Seapan to produce the claimed invention. Furthermore, since the regeneration processes of Cooper and Seapan rely on solvents that do not include a source of a hydride ion, it was not a predictable solution to utilize a fluid reactivating agent at or above its critical point and comprising a source of a hydride ion in such a process.

It is further submitted that Examiner has not articulated any reasoning that would support the conclusion of obviousness. The Examiner states that “Seapan discloses supercritical treatment” and that the alleged “hydrocarbon reactivating agents” of Cooper are “hydride ions sources.” *See* Office Action of October 3, 2007, p. 5. While Seapan teaches that tetrahydrofuran, pyridine, carbon dioxide, and sulfur dioxide may be used to regenerate a catalyst under supercritical conditions, Cooper teaches a catalyst regeneration step that involves contacting the catalyst with a liquid solution including a solvent, such as SO₂, oxygenates, such

as C₁-C₄ alcohols, ketones, and aldehydes, nitriles, or phenols. Accordingly, one of ordinary skill would not be motivated to utilize a hydride ion source in the regeneration process of Cooper based on the teachings of the applied references. Aside from the mention of Seapan in the background section of Cooper, the Examiner has not provided an apparent reason that would prompt one of ordinary skill in the art to combine the applied references in the manner claimed. Absent an apparent reason that would have prompted one of ordinary skill to combine the known elements in the fashion claimed, it is respectfully submitted that a *prima facie* case of obviousness has not been met.

It is further submitted that the combination of Cooper and Seapan does not render the rejected claims obvious because the combination lacks a reasonable expectation of success. “Obviousness does not require absolute predictability, however, at least some degree of predictability is required.” M.P.E.P. § 2143.02. “[W]hether the proposed modification or combination of the prior art has a reasonable expectation of success is determined at the time the invention was made.” *Id.* Since Cooper teaches separating the compounds asserted by the Examiner to be “hydrocarbon reactivating agents” prior to regeneration of the catalyst, one of ordinary skill in the art would not have had a reasonable expectation of success in utilizing such compounds in a catalyst regeneration process.

ENTRY OF AMENDMENTS

The amendments to claims 1, 5, 7-19, 38 and 43 above should be entered by the Examiner because the amendments are supported by the as-filed specification and drawings and do not add any new matter to the application. Further, the amendments do not raise new issues or require a further search.

CONCLUSION

Claims 1-20, 22-31, and 38-46 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, the Examiner is respectfully invited to contact Applicants' undersigned attorney.

Respectfully submitted,

/Stephen R. Christian/

Stephen R. Christian
Registration No. 32,687
Attorney for Applicants
P.O. Box 1625
Idaho Falls, ID 83415-3899
Phone: (208) 526-9140
Fax: (208) 526-8339

Date: 30 January 2008

Material Safety Data Sheet

Airgas

Isobutylene

Section 1. Chemical product and company identification

Product Name : Isobutylene
 Supplier : AIRGAS INC., on behalf of its subsidiaries
 259 North Radnor-Chester Road
 Suite 100
 Radnor, PA 19087-5283
 1-610-687-5253
 Product use : Synthetic/Analytical chemistry.
 MSDS# : 001031
 Date of Preparation/Revision : 4/3/2007.
 In case of emergency : 1-866-734-3438

Section 2. Hazards identification

Physical state : Gas. (COLORLESS LIQUEFIED COMPRESSED GAS WITH A SWEET GASOLINE-LIKE ODOR)
 Emergency overview : Warning!
 FLAMMABLE GAS.
 CONTENTS UNDER PRESSURE.
 VAPOR MAY CAUSE FLASH FIRE.
 Keep away from heat, sparks and flame. Do not puncture or incinerate container. Keep container closed. Use only with adequate ventilation.
 Contact with rapidly expanding gases can cause frostbite.
 Routes of entry : Inhalation
Potential acute health effects
 Eyes : No known significant effects or critical hazards.
 Skin : No known significant effects or critical hazards.
 Inhalation : Acts as a simple asphyxiant.
 Ingestion : Ingestion is not a normal route of exposure for gases
 Potential chronic health effects : **CARCINOGENIC EFFECTS** Not available.
MUTAGENIC EFFECTS Not available.
TERATOGENIC EFFECTS Not available.
 Medical conditions aggravated by overexposure : Acute or chronic respiratory conditions may be aggravated by overexposure to this gas.
 See toxicological Information (section 11)

Section 3. Composition, Information on Ingredients

Name	CAS number	% Volume	Exposure limits
Isobutylene	115-11-7	100	Del Lietuvos Higienos Normos (Lithuania, 12/2001). TWA: 100 mg/m ³ 8 hour(s). Form: All forms

Section 4. First aid measures

No action shall be taken involving any personal risk or without suitable training. If fumes are still suspected to be present, the rescuer should wear an appropriate mask or a self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

Eye contact : In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.
 Skin contact : In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Isobutylene

- Frostbite** : Try to warm up the frozen tissues and seek medical attention.
- Inhalation** : If inhaled, remove to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Get medical attention.
- Ingestion** : Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention if symptoms appear.

Section 5. Fire fighting measures

- Flammability of the product** : Flammable.
- Auto-ignition temperature** : 465°C (869°F)
- Flammable limits** : Lower: 1.8% Upper: 9.6%
- Products of combustion** : These products are carbon oxides (CO, CO₂).
- Fire hazards in presence of various substances** : Extremely flammable in presence of open flames, sparks and static discharge, of oxidizing materials.
- Fire fighting media and instructions** : In case of fire, use water spray (fog), foam, dry chemicals, or CO₂.
- If involved in fire, shut off flow immediately if it can be done without risk. Apply water from a safe distance to cool container and protect surrounding area.
- Extremely flammable. Gas may accumulate in confined areas, travel considerable distance to source of ignition and flash back causing fire or explosion.
- Special protective equipment for fire-fighters** : Fire fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full facepiece operated in positive pressure mode.

Section 6. Accidental release measures

- Personal precautions** : Immediately contact emergency personnel. Keep unnecessary personnel away. Use suitable protective equipment (Section 8). Shut off gas supply if this can be done safely. Isolate area until gas has dispersed.
- Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 7. Handling and storage

- Handling** : Keep container closed. Use only with adequate ventilation. Keep away from heat, sparks and flame. To avoid fire, minimize ignition sources. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Do not puncture or incinerate container. High pressure gas. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.
- Storage** : Keep container tightly closed. Keep container in a cool, well-ventilated area. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure Controls, Personal Protection

- Engineering controls** : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. The engineering controls also need to keep gas, vapor or dust concentrations below any explosive limits. Use explosion-proof ventilation equipment.

Personal protection

- Eyes** : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts.
- Skin** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Isobutylene

- Respiratory : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.
The applicable standards are (US) 29 CFR 1910.134 and (Canada) Z94.4-93
- Hands : Chemical-resistant, impervious gloves or gauntlets complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.
- Personal protection in case of a large spill : A self-contained breathing apparatus should be used to avoid inhalation of the product.

Consult local authorities for acceptable exposure limits.

Section 9. Physical and chemical properties

- Molecular weight : 56.12 g/mole
- Molecular formula : C₄H₈
- Boiling/condensation point : -6.89°C (19.6°F)
- Melting/freezing point : -139.99°C (-220°F)
- Critical temperature : 144.8°C (292.6°F)
- Vapor pressure : 24.3 psig
- Vapor density : 1.9 (Air = 1)
- Specific Volume (ft³/lb) : 6.68449
- Gas Density (lb/ft³) : 0.1496

Section 10. Stability and reactivity

- Stability and reactivity : The product is stable.
- Incompatibility with various substances : Extremely reactive or incompatible with oxidizing agents.

Section 11. Toxicological information

- Other toxic effects on humans : No specific information is available in our database regarding the other toxic effects of this material for humans.

Specific effects

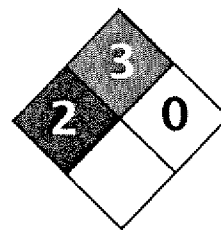
- Carcinogenic effects : No known significant effects or critical hazards.
- Mutagenic effects : No known significant effects or critical hazards.
- Reproduction toxicity : No known significant effects or critical hazards.

Section 12. Ecological information

- Products of degradation : These products are carbon oxides (CO, CO₂) and water.
- Toxicity of the products of biodegradation : The product itself and its products of degradation are not toxic.
- Environmental fate : Not available.
- Environmental hazards : No known significant effects or critical hazards.
- Toxicity to the environment : Not available.

Section 13. Disposal considerations

Product removed from the cylinder must be disposed of in accordance with appropriate Federal, State, local regulation. Return cylinders with residual product to Airgas, Inc. Do not dispose of locally.



Health	2
Fire	3
Reactivity	0
Personal Protection	H

Material Safety Data Sheet Benzene MSDS

Section 1: Chemical Product and Company Identification

Product Name: Benzene

Catalog Codes: SLB1564, SLB3055, SLB2881

CAS#: 71-43-2

RTECS: CY1400000

TSCA: TSCA 8(b) inventory: Benzene

CI#: Not available.

Synonym: Benzol; Benzine

Chemical Name: Benzene

Chemical Formula: C₆H₆

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: 1-800-901-7247
International Sales: 1-281-441-4400

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Benzene	71-43-2	100

Toxicological Data on Ingredients: Benzene: ORAL (LD50): Acute: 930 mg/kg [Rat]. 4700 mg/kg [Mouse]. DERMAL (LD50): Acute: >9400 mg/kg [Rabbit]. VAPOR (LC50): Acute: 10000 ppm 7 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:

Very hazardous in case of eye contact (irritant), of inhalation. Hazardous in case of skin contact (irritant, permeator), of ingestion. Inflammation of the eye is characterized by redness, watering, and itching.

Potential Chronic Health Effects:

CARCINOGENIC EFFECTS: Classified A1 (Confirmed for human.) by ACGIH, 1 (Proven for human.) by IARC.

MUTAGENIC EFFECTS: Classified POSSIBLE for human. Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast.

TERATOGENIC EFFECTS: Not available.

DEVELOPMENTAL TOXICITY: Classified Reproductive system/toxin/female [POSSIBLE].

The substance is toxic to blood, bone marrow, central nervous system (CNS).

The substance may be toxic to liver, Urinary System.

Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:

Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. WARM water MUST be used. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water. Cover the irritated skin with an emollient. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.

Serious Skin Contact:

Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if symptoms appear.

Serious Inhalation:

Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:

Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Flammable.

Auto-Ignition Temperature: 497.78°C (928°F)

Flash Points: CLOSED CUP: -11.1°C (12°F). (Setaflash)

Flammable Limits: LOWER: 1.2% UPPER: 7.8%

Products of Combustion: These products are carbon oxides (CO, CO₂).

Fire Hazards in Presence of Various Substances:

Highly flammable in presence of open flames and sparks, of heat.
Slightly flammable to flammable in presence of oxidizing materials.
Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.
Explosive in presence of oxidizing materials, of acids.

Fire Fighting Media and Instructions:

Flammable liquid, soluble or dispersed in water.
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use alcohol foam, water spray or fog.

Special Remarks on Fire Hazards:

Extremely flammable liquid and vapor. Vapor may cause flash fire.
Reacts on contact with iodine heptafluoride gas.

Dioxygenyl tetrafluoroborate is as very powerful oxidant. The addition of a small particle to small samples of benzene, at ambient temperature, causes ignition.
Contact with sodium peroxide with benzene causes ignition.
Benzene ignites in contact with powdered chromic anhydride.
Virgorous or incandescent reaction with hydrogen + Raney nickel (above 210 C) and bromine trifluoride.

Special Remarks on Explosion Hazards:

Benzene vapors + chlorine and light causes explosion.
Reacts explosively with bromine pentafluoride, chlorine, chlorine trifluoride, diborane, nitric acid, nitryl perchlorate, liquid oxygen, ozone, silver perchlorate.
Benzene + pentafluoride and methoxide (from arsenic pentafluoride and potassium methoxide) in trichlorotrifluoroethane causes explosion.
Interaction of nitryl perchlorate with benzene gave a slight explosion and flash.
The solution of permanganic acid (or its explosive anhydride, dimaganese heptoxide) produced by interaction of permanganates and sulfuric acid will explode on contact with benzene.
Peroxodisulfuric acid is a very powerful oxidant. Uncontrolled contact with benzene may cause explosion.
Mixtures of peroxomonsulfuric acid with benzene explodes.

Section 6: Accidental Release Measures

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:

Flammable liquid.

Keep away from heat. Keep away from sources of ignition. Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not touch spilled material. Prevent entry into sewers, basements or confined areas; dike if needed. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:

Keep locked up.. Keep away from heat. Keep away from sources of ignition. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, acids.

Storage:

Store in a segregated and approved area. Keep container in a cool, well-ventilated area. Keep container tightly closed and sealed until ready for use. Avoid all possible sources of ignition (spark or flame).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:

Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:

Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:

Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:

TWA: 0.5 STEL: 2.5 (ppm) from ACGIH (TLV) [United States]
TWA: 1.6 STEL: 8 (mg/m³) from ACGIH (TLV) [United States]
TWA: 0.1 STEL: 1 from NIOSH
TWA: 1 STEL: 5 (ppm) from OSHA (PEL) [United States]
TWA: 10 (ppm) from OSHA (PEL) [United States]
TWA: 3 (ppm) [United Kingdom (UK)]
TWA: 1.6 (mg/m³) [United Kingdom (UK)]
TWA: 1 (ppm) [Canada]
TWA: 3.2 (mg/m³) [Canada]
TWA: 0.5 (ppm) [Canada] Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor:

Aromatic. Gasoline-like, rather pleasant.
(Strong.)

Taste: Not available.

Molecular Weight: 78.11 g/mole

Color: Clear Colorless. Colorless to light yellow.

pH (1% soln/water): Not available.

Boiling Point: 80.1 (176.2°F)

Melting Point: 5.5°C (41.9°F)

Critical Temperature: 288.9°C (552°F)

Specific Gravity: 0.8787 @ 15 C (Water = 1)

Vapor Pressure: 10 kPa (@ 20°C)

Vapor Density: 2.8 (Air = 1)

Volatility: Not available.

Odor Threshold: 4.68 ppm

Water/Oil Dist. Coeff.: The product is more soluble in oil; log(oil/water) = 2.1

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, diethyl ether, acetone.

Solubility:

Miscible in alcohol, chloroform, carbon disulfide oils, carbon tetrachloride, glacial acetic acid, diethyl ether, acetone.
Very slightly soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.